2.3.20. Introduction to Advanced Air-to-Air Radar Test Techniques

As mentioned in Chapter 1, only the most rudimentary form of the air-to-air radar test techniques are presented in this book. Chapter 1 details the reasons for this format; however, in many applications, more rigor, accuracy and documentation of results are required. Table I outlines additional instrumentation and assets which are typically applied in these more advanced tests. The purpose of this table is merely to emphasize the existence of these advanced techniques. Further, this list is not exhaustive. Many innovative uses of assets and instrumentation exist. It is hoped that the examples provided leave the reader with a taste of how the test can be made more rigorous through the judicious use of instrumentation. In application; the user must refer to the more advanced documents referenced in Chapter 1 or solicit help from more experienced testers.

Table I: Additional Assets or Instrumentation for use in Advanced Air-to-Air Radar Tests

Test	Additional Asset or Instrumentation	Purpose/Benefit
Preflight and Built-in-Tests.	Digital Recorder.	Typically records data from data bus on which radar passes the BIT results. Allows precise documentation of test results. Usually used in conjunction with fault insertion tests.
	Video recording of display.	Provides automatic recording of what the operator sees as a fault status is displayed.
Controls and Displays.	Video recording of display.	Allows automatic documentation of display problems as well as post-flight analysis and evaluation.
	Cockpit mock-ups, reconfigurable cockpits and virtual cockpits.	Typically used for in-depth ground tests of human factors and in iterative cockpit design.
	Digital recording of operator actions.	Can be used as a means of precisely recording operator selections to document noted problems and as a means of performing operator tasking analysis.
Scan Rate.	Digital recording of radar data.	In some systems the sweep position can be digitally recorded as output of a scan converter. In this case the instantaneous as well as the average scan rate can be calculated as required.
	Time stamped video recording of display.	Even in the absence of digital data, the instantaneous and average scan rates can be derived using appropriately time stamped video.

Table I: Additional Assets or Instrumentation for use in Advanced Air-to-Air Radar Tests (Continued)

Test	Additional Asset or Instrumentation	Purpose/Benefit
Scan Angle Limits.	Digital Recording of aircraft heading and position for both the target and test aircraft, time stamped video recording of display.	The test can be made more accurate by recording the precise target and test aircraft location, precise test aircraft heading (these parameters are either derived and recorded on-board or using a space positioning range as appropriate) as well as precise time. The radar display is video recorded and time stamped and as the target disappears, the exact angle off boresight can be calculated based upon geometric calculations.
Elevation Angle Limits.	Similar to scan angle limits except vertical angles are recorded vice headings.	Similar to scan angle limits except the vertical angles to the target are calculated vice the horizontal angles.
Tracking Rate limits.	Digital recording of test and target airplane positions, test airplane heading and turning rate, radar data including STT positions and track files and time stamp.	The test and target airplane positions and the test airplane turning rate (may be derived using onboard or range space positioning data) are geometrically reduced to derive the crossing rate of the target at the time that the radar data indicates that the radar has lost track.
Antenna Stabilization Limits.	Digital recording of test aircraft time stamped roll, pitch and yaw rates and time stamped video recording of the display.	The direct measurement of the roll, pitch and yaw rates are correlated to degradation on the time stamped display.
Range and Bearing Accuracy.	Digital recording of time stamped test and target aircraft position and time stamped radar display video or digital radar track files with radar derived bearing and range to target.	Target and test aircraft location from either onboard instrumentation or range space positioning data are used to calculate the actual range and bearing to the target at the time a range and bearing is derived using the radar. The video recorded range and bearing are compared directly and may in turn be compared to the range and bearing within the radar track file.
Range and Bearing Resolution.	Precise control of target locations is provided by an instrumented range. Digital recording of time stamped target and test aircraft location. Video recording of the radar display.	Precise control of the targets can help prevent range contamination of the bearing resolution data point. The resolutions can be directly determined by geometrically comparing the positions of the targets and the test airplane at the time breakout occurs.

Table I: Additional Assets or Instrumentation for use in Advanced Air-to-Air Radar Tests (Continued)

Test	Additional Asset or Instrumentation	Purpose/Benefit
Maximum Detection Range.	Digital recording of time stamped radar detections. Video recording of time stamped radar display. Time stamped test and target aircraft locations. Propagation prediction assets. Real time measurement of casual interference.	The test and target aircraft locations are geometrically reduced to provide actual, time stamped locations of the target in radar space. This information is used to validate hits and misses at corresponding bearings and ranges on the target as recorded on the radar display and digitally recorded radar detection data. Often, the real time propagation performance is predicted on instrumented ranges for the frequency of the test radar and casual interference is recorded on the aircraft using special instrumentation. Sometimes this information is already designed into the test radar and needs only to be recorded.
Maximum Unambiguous Range.	Video recording of time stamped radar display. Time stamped test and target aircraft locations.	The geometrically reduced test and target locations are used to verify the displayed range to the target after detection.
Maximum Acquisition Range.	Same as Maximum Detection Range with the addition of track file data and operator selection of STT.	Range to the target is geometrically derived from the time stamped space positioning data when the recorded video shows that the operator has successfully been able to acquire the target.
Blind Ranges.	Same as Maximum Detection Range test.	Reduction similar to Maximum Detection Range Test with data plots the same as in the test described in this book. Emphasis is placed upon the statistical significance and repeatability of the blind ranges.
Groundspeed /Course /Altitude Accuracy.	Digital recording of time stamped target aircraft location, groundspeed, course and altitude. Video recording of the time stamped radar display.	Internally recorded or range derived target parameters are time correlated to the displayed radar information.
Velocity Resolution.	Digital recording of time stamped target aircraft groundspeed. Video recording of the time stamped radar display.	Internally recorded or range derived target groundspeeds are time correlated to the displayed radar information at breakout.

Table I: Additional Assets or Instrumentation for use in Advanced Air-to-Air Radar Tests (Continued)

Test	Additional Asset or Instrumentation	Purpose/Benefit
Blind Speeds.	Digital recording of precise time stamped target and test aircraft heading and groundspeed. Video recording of the time stamped radar display.	High accuracy as well as high update and recording rates are necessary to get accurate target closure rates during maneuvers. Can be derived onboard or on a space positioning range. Time correlated target and test aircraft parameters are compared to the geometrically derived closure rate. This is compared to drop-outs in the radar display. Emphasis is placed upon the statistical significance and repeatability of the blind speeds.
Air Combat Modes.	Digital recording of precise, time stamped test and target aircraft positions, rates and accelerations; digital recording of time stamped radar data, time stamped video recording of the radar and head up display.	For complete documentation, this test requires precise documentation of all target and test aircraft dynamics and locations, which are then time correlated with radar data and the operator displays.
False Alarm Rate.	Ground radar coverage and time stamped recording of the entire radar search volume. Time stamped video recording of the radar display. Digital recording of time stamped radar detection data.	Radar detection data are time correlated with the ground radar detection data to verify or disprove the existence of actual radar targets.
Track File Capacity.	Video recording of the radar display.	Since the test simply verifies the maximum track file number, the recording of the radar display provides some added documentation.
Mission Utility and Integration.	Digital recording of precise, time stamped test and target aircraft positions, rates and accelerations; digital recording of time stamped radar data; time stamped video recording of radar and head up display.	This test requires the largest amount of data to completely document the results. It is during this test that most of the unexpected problems are found. In anticipation of having to document these deficiencies, maximum instrumentation and range support are sometimes brought to bear in case unforseen data are required in post-flight analysis.